(12) UK Patent Application (19) GB (11) 2 358 389 (13) A

(43) Date of A Publication 25.07.2001

(21) Application No 0031686.9

(22) Date of Filing 22.12.2000

(30) Priority Data
(31) 9930491 (32) 23.12.1999 (33) GB

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(51) INT CL[7]
B66B 9/08

(52) UK CL (Edition S)
B8L LFB

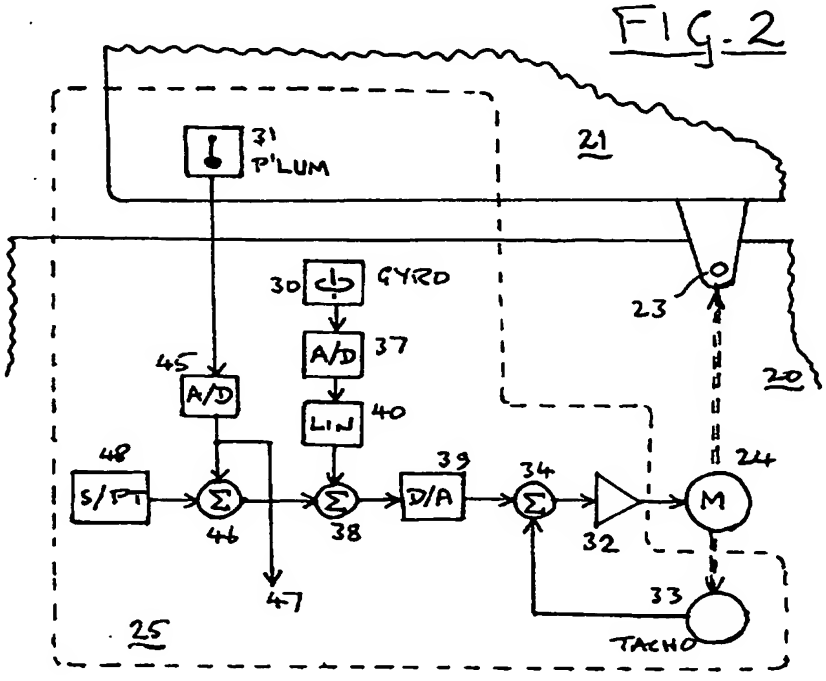
(56) Documents Cited
GB 2301811 A WO 99/46198 A WO 99/29611 A
WO 98/39241 A WO 98/37007 A

(58) Field of Search
UK CL (Edition S) B8L LFB LFJ LFX LGX
INT CL[7] B66B 9/08

(54) Abstract Title
Stairlift seat orientation controller

(57) A stairlift comprises a rail with sloping and level portions (11, 12 figure 1), a carriage (20 figure 1) movable up and down the rail with a seat 21 pivotally mounted on it. The chassis tilts as it moves along the rail and a motor 24 drives the seat to keep it level. The motor is controlled by level control circuitry 25, which has a gyroscope 30 to sense angular velocity of the chassis and a pendulum 31 to sense the angular position of the seat and to correct for gyroscopic drift. A set point signal unit 48 can be used to set the quiescent seat angle and optionally threshold circuitry can be included to prevent the motor from being driven until the drive signal exceeds a predetermined level. The level control circuitry can be switched off on straight sections.

FIG. 2



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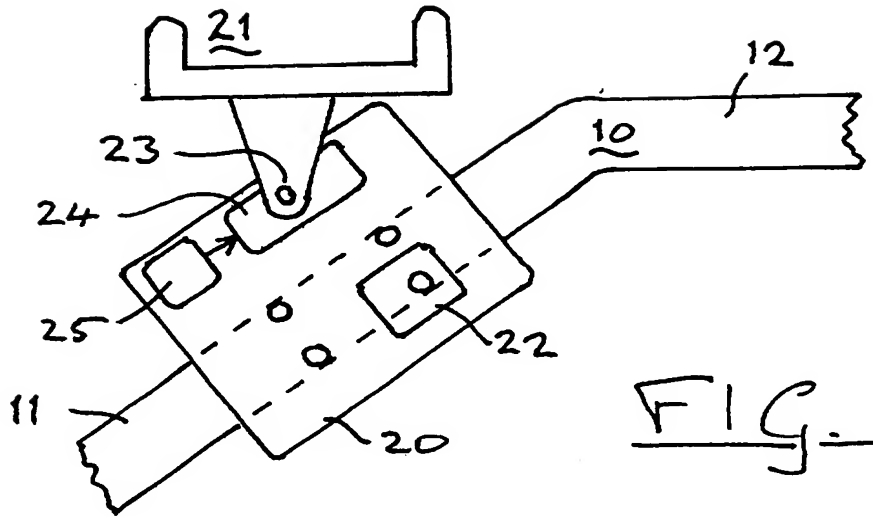
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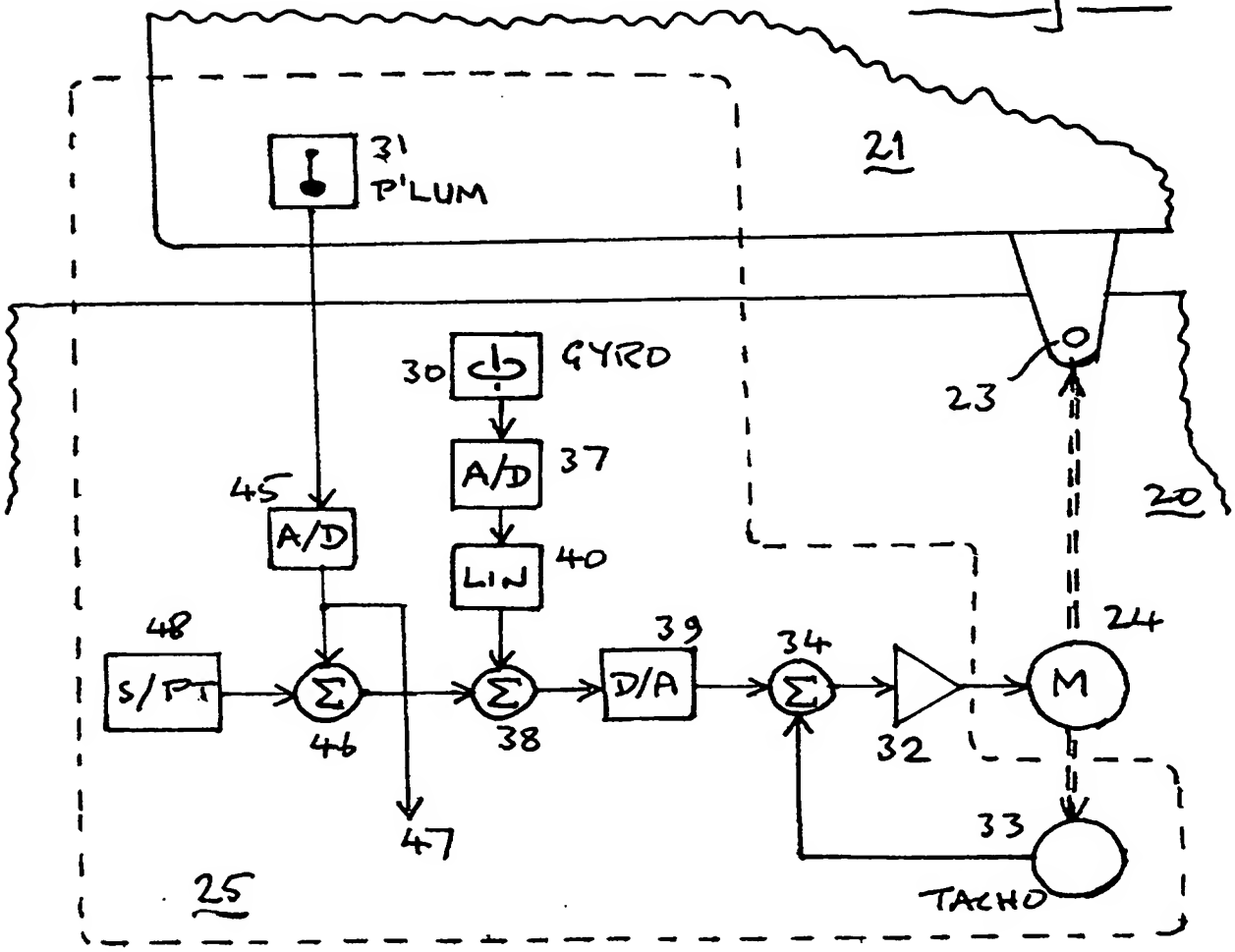
FIG. 1

FIG. 2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Stairlifts

The present invention relates to stairlifts, and more specifically to maintaining the seat of a stairlift level.

A stairlift is essentially a carriage which is supported on a track consisting of rail means which are attached to a staircase so that the carriage can be moved automatically up and down the staircase. The carriage consists of a seat mounted in a chassis. Such stairlifts are used primarily by old and/or disabled people who find it difficult or impossible to go up and down stairs unaided.

If the staircase is a simple straight run, it is possible for the seat to be fixed on the chassis. It is however desirable for the track to have level segments at the top and/or bottom, so that the user can get on and off comfortably and without coming too close to or onto the top or bottom of the stairs. Also, many staircases are not simple straight runs but have turns and/or landings where the gradient (and often also the direction) of the stairlift track has to change. The track has to follow these turns and changes of gradient, and the chassis will tilt as it ascends or descends the track. It is then necessary for the seat of the stairlift to be mounted on the chassis in such a way that the seat is kept level as the angle of the chassis changes.

It is possible to achieve this by purely mechanical techniques. However, these have their difficulties, and electrical/electronic servomechanisms have been proposed.

One such technique is described in WO 95/18763, Stannah Stairlifts. In this, a memory is used to store the desired angle between the chassis and the seat for different positions along the rail. As the carriage moves along the rail in use, so its position is

monitored. The carriage can be driven by a rack and pinion mechanism, with the turns of the driving pinion being counted to determine its position. As the chair passes through successive positions, so the seat angles for those positions are read from the memory and fed to the carriage to actuate a seat levelling motor to maintain the seat level. A PID (proportional/integral/differential) control system may be used. The seat may carry a pendulum for calibration; for this, the carriage is driven to each successive position in turn and stopped, and the angle of the pendulum recorded in the memory.

A further such technique is described in WO 98/37007, Bison Bede/DC Drives. In this, an inclinometer is fixed to the seat, and its output is used to drive the seat levelling motor. The inclinometer consists of an inertial mass mounted on a stiff arm with a strain gauge and located on the axis of rotation of the seat on the carriage. A pendulum is also mounted on the seat, to sense substantially static inclinations.

The general object of the present invention is to provide an improved technique for maintaining the seat of a stairlift carriage level.

According to the invention there is provided a stairlift carriage comprising a chassis having a seat rockably mounted thereon, level control circuitry fed by level sensing means for sensing deviations of the seat from the horizontal, and a seat levelling motor controlled by the level control circuitry, wherein the level control circuitry includes angular velocity sensing means mounted on the chassis.

As the chair moves up and down its track, the chassis will, as discussed above, tilt (ie undergo angular rotation) with the changes of gradient of the track, as discussed above. In the present system, the velocity of the angular rotation of the chassis is sensed and used to drive the seat levelling motor to produce a substantially equal and opposite angular rotation of the seat, so keeping the seat level. The level sensing means on the seat are used to sense and correct any inaccuracies in the angular velocity control.

The angular velocity sensing means preferably comprise a gyroscope which produces an output proportional to the angular velocity (rate of turn) of the chassis. Preferably also the level sensing means comprise a pendulum for measuring static deviations of the seat. The seat mounting of the seat on the carriage can conveniently comprise a shaft to which the seat is attached and which is rotatably mounted on the carriage.

A velocity signal sensor such as a tachometer is preferably coupled to the seat levelling motor and feeding the level control circuitry. The position of the pendulum may be sensed by any convenient means, such as a rotary potentiometer or a shaft position encoder.

A stairlift embodying the invention will now be described, by way of example, with reference to the drawings, in which:

Fig. 1 is a diagrammatic view of the stairlift; and

Fig. 2 is a block diagram of the level control circuitry.

Referring to Fig. 1, the stairlift consists of a track 10 and a carriage consisting of a chassis 20 mounted on the track and a seat 21 mounted on the chassis. The chassis 20 includes a main drive motor 22 for driving the carriage up and down the track 10, eg by a rack and pinion drive. The seat 21 is mounted on the chassis 20 via a pivot mounting 23 which is driven by a seat levelling motor 24. A control unit 25 carried on the carriage, and controls the motor 24.

The track or rail 10 typically follows a staircase, and is firmly attached to the staircase. If the staircase has bends in it, the track will follow round those bends; if it has landings, it will follow horizontally across those landings; and it may also have horizontal

sections at one or both ends. Thus it will have sections of different gradients, as shown for sections 11 and 12 in Fig. 1.

The carriage moves up and down track 10, to carry the occupant of the seat 21 up or down stairs, being driven by any suitable means such as a motor 22 mounted on the chassis and engaging with the track 10. As the carriage moves up and down the track 10, it will tilt to different extents as the gradient of the track changes. The seat 21, however, must be maintained horizontal, to keep its occupant comfortable and prevent them from falling off. The seat 21 is pivotally mounted on the chassis 20 by a shaft 23, which is driven by the seat levelling motor 24. The angle of the seat 20 to the vertical is determined by the level control unit 25, which drives the motor 24 appropriately.

The drive from the levelling motor 24 to the shaft 23 is preferably non-reversible, so that the seat cannot drive the motor and so tilt as a result of loads placed on the seat. Preferably also, however, a mechanical lock (not shown) is arranged to engage with the drive from the motor to the seat if the control system is switched off or otherwise becomes inoperative.

Fig. 2 shows the level control unit 25 in more detail. This includes a gyroscope unit 30 mounted on the chassis 20 and a pendulum unit 31 mounted on the seat 21; the remainder of the circuitry can obviously be located wherever convenient.

It is convenient to begin the description of the circuitry at the motor end. The motor 24 is driven by a driver circuit 32. The motor drives the shaft 23, as noted above, and also drives a tachometer (tacho) unit 33, whose output is fed back to the negative input of a summing unit 34 which feeds the driver circuit 32. This summing unit is also fed with a velocity demand signal which will be described shortly. The feedback loop through the tacho unit 33 balances the actual velocity of the motor, as measured by the tacho unit, with

the velocity demand signal, thus ensuring that the motor velocity matches the velocity demand signal.

The gyroscope unit 30, which is mounted on the chassis 20, generates an output signal which is proportional to its angular velocity. Thus if the chassis starts to tilt, the gyro signal will be proportional to its rate of tilt. This output signal is converted to digital form by an A/D converter 37 and passed through a linearizing circuit 40 to a summing unit 38, which feeds a D/A converter 39 which produces the velocity demand signal mentioned above. Thus if the chassis 20 is tilted, the rate of tilt will generate a corresponding velocity demand signal, which will drive the motor 24 to rotate the seat 21 with an equal and opposite velocity.

The gyro unit 30, of course, measures the rate of tilt of the chassis 20 relative to an absolute or fixed frame of reference. As the carriage moves up and down the track 10, so the chassis will tilt as it moves past bends such as the bend between sections 11 and 12 (Fig. 1). The seat 21 will tend to tilt with the chassis, but any tilting of the chassis is detected by the gyro unit 30, and the level control unit 25 operates as just described to generate an equal and opposite tilt on the seat, so keeping the seat level.

Cheap and rugged gyro units suitable for present purposes are readily available. However, such units, and the control system associated with them, may not be sufficiently accurate when used at the required operating speed, and are also liable to slow long-term drift. The pendulum unit 31, fixed to the seat 21, is therefore included, to give an absolute measure of the angular position of the seat. The control circuit combines this signal with that from the gyro in such a way as to maintain the required rapid response capability of the gyro, but with much increased accuracy. It is also able to maintain long-term horizontality. Specifically, the pendulum unit may consist of an oil-damped pendulum coupled to a rotary potentiometer whose output is fed via an A/D converter 45 to a summing unit 46 which feeds the summing unit 38.

In practice, the pendulum and the gyroscope will both be operating together to maintain the seat horizontal. To understand the operation of the pendulum, however, it is convenient to suppose for the purposes of illustration that the carriage is stationary and the seat has somehow been set at an angle to the horizontal by the gyro unit. The signal from the pendulum unit will generate a velocity signal which will cause the motor 24 to run and so rotate the seat. As the seat rotates towards the horizontal, so the pendulum output signal will decrease towards zero, and the rate at which the seat is rotating towards zero will also decrease until the system reaches stability when the seat is horizontal. Since the gyroscope is attached to the chassis, there will be no change in the output of the gyroscope during this pendulum-controlled correction.

The sensitivity of the level control unit to the pendulum signal is set low, so that the system does not react significantly to pendulum movements resulting from movement of the carriage. In other words, the time constant of the level control unit's response to changes in the pendulum output is long compared to the natural period of the pendulum and its response to carriage movement. The pendulum signal control circuit preferably includes PI (proportional plus integral) control circuitry.

A set-point signal unit 48 feeds the summing unit 46, and can be used to adjust the seat angle for which the system is quiescent.

The output from the pendulum unit (or the summing unit 46) is preferably also fed, as shown at 47, to safety circuitry (not shown) which interrupts the main power supply and halts the carriage if the angle of the seat exceeds a predetermined limit. The oil damping of the pendulum effectively smooths or low-pass filters its output signal, preventing it from producing jerkiness when carriage is moving, and particularly when it is undergoing changes of movement. The effect of carriage movement on the safety circuit signal at 47 is therefore not excessive.

If desired, threshold circuitry can be included to prevent the motor 24 from being driven until the drive signal to it exceeds a predetermined level. This will prevent hunting and reduce the power consumption.

Means can be provided for indicating when the carriage is on a straight section of rail. This can be achieved, for example, by a simple form of memory like that used in the Stannah Stairlifts system mentioned above, or by attaching indicator elements to the rail 10 and sensor means to the carriage. The entire level control unit 25 can then also be switched off on such straight rail sections.

The A/D converters 37 and 45 may be formed by a single converter time-shared between the two sensors 30 and 31.

Claims

1 A stairlift carriage comprising a chassis having a seat rockably mounted thereon, level control circuitry including level sensing means for sensing deviations of the seat from the horizontal, and a seat levelling motor controlled by the level control circuitry, wherein the level control circuitry includes angular velocity sensing means mounted on the chassis.

2 A stairlift according to claim 1 wherein the angular velocity sensing means comprise a gyroscope which produces an output proportional to the angular velocity (rate of turn) of the chassis.

3 A stairlift according to any previous claim wherein the seat is mounted on the carriage by means of a shaft to which the seat is attached and which is rotatably mounted on the carriage.

4 A stairlift according to any previous claim wherein the level control circuitry includes a velocity signal sensor coupled to the seat levelling motor and providing a feedback signal for the motor.

5 A stairlift according to any previous claim wherein the level control circuitry includes a set-point signal unit feeding a summing unit and effective to adjust the seat angle for which the system is quiescent.

6 A stairlift according to any previous claim wherein the level sensing means further comprise a pendulum for measuring static deviations of the seat.

9 A stairlift according to claim 6 wherein the position of the pendulum is sensed by a shaft position encoder.

10 A stairlift according to claim 6 wherein the position of the pendulum is sensed by a rotary potentiometer.

11 A stairlift according to any of claims 6 to 9 wherein the output from the pendulum is also fed to safety circuitry which halts the carriage if the angle of the seat exceeds a predetermined limit.

12 A stairlift according to any previous claim wherein the level sensing means further comprise threshold circuitry to prevent the motor from being driven until the drive signal to it exceeds a predetermined level.

13 A stairlift according to any previous claim including means for indicating when the carriage is on a straight section of rail.

14 A stairlift according to claim 13 including a memory.

15 A stairlift according to claim 13 including indicator elements attached to the rail and sensor means attached to the carriage.

16 A stairlift substantially as herein described and illustrated.

17 Any novel and inventive feature or combination of features specifically disclosed herein within the meaning of Article 4H of the International Convention (Paris Convention).

Application No: GB 0031686.9 **Examiner:** Richard Baines
Claims searched: 1 - 16 **Date of search:** 14 May 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): B8L (LFB, LFJ, LFX, LGX)

Int Cl (Ed.7): B66B 9/08

Other: Online: EPODOC, WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2,301,811 A	BISON BEDE	
X	WO 99/46198	BISON BEDE - figure 5 and page 6, especially lines 22 to 27	1, 3, 4, 6 & 11
X	WO 99/29611	THYSSEN - figure 3 and page 12 lines 27 to 31	1,3 & 4
A	WO 98/39241	ERLANDSSON	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.